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United States Environmental Protection Agency
Washington, DC 20460

Work Assignment

Work Assignment Number
0-1 Amendment 4

[ ] Original [X] Amendment Number: 4

Contract Number
EP-C-07-028

Contract Period Base

Title of Work Assignment:
Comprehensive Gasoline Light Duty Exhaust Fuel Effects Test Program to Cover Multiple Fuel Properties and Two Ambient Test Temperatures

Contractor

Specify Section and Paragraph of Contract SOW

Purpose: Work Assignment Initiation [] Work Assignment Close-Out
[X] Work Assignment Amendment [] Incremental Funding
[] Work Plan Approval

Periods of Performance
From: Effective Date To: 6/27/08

Comments: Since a work plan has initially been completed, EPA request to have the revised work plan returned within 5 working days vice the normal 15 calendar days.

[] Superfund **Accounting and Appropriations Data** [] Non-Superfund

Lin	DC (Max 8)	Budget/FY	Appropriation Code (Max	Budget Org/Code (Max 7)	Program Element (Max 9)	Object Class (Max 4)	Amount (Dollars)	(Cents)	Site/Project (Max 8)	Cost Org/Code (Max 7)
1										
2										
3										
4										
5										

Authorized Work Assignment Ceiling

Contract Period:	Cost/Fee	
This Action		
Total		
Contractor WP Dated :	Cost/Fee:	
Cumulative Approved:	Cost/Fee:	

Ex. 4 - CBI

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Contractor Acknowledgement of Receipt and Approval of Workplan *(Signature and Title)* Date

EPA Form 1900-69 (Rev. 07-95)

Performance Work Statement

Contract EP-C-07-018	Work Assignment Number 01 Amendment 4
Issuing Office	Environmental Protection Agency 2000 Traverwood Drive Ann Arbor, MI 48105-2498
Contractor	Southwest Research Institute 6220 Culebra Rd. San Antonio, TX 78228-0510
Title	Comprehensive Gasoline Light Duty Exhaust Fuel Effects Test Program to Cover Multiple Fuel Properties and Two Ambient Test Temperatures

Background

As Per Amendment 3

Scope and Objectives

As Per Amendment 3

Work Requirements

As Per Amendment 3

Task 1 Work Plan Development

As Per Amendment 3

Task 2 Quality-Assurance Project Plan and Quality Management Plan (QAPP/QMP)

As Per Amendment 3

Task 3 Vehicle Recruitment

The contractor shall acquire (through lease, purchase, or alternate recruitment technique approved by the EPA WAM) 19 test vehicles for use in this program. All of these vehicles must be/have been certified and sold as being compliant with the Federal Tier 2 emissions standards, and shall be selected from the vehicles listed in Table 3-1 . Of these vehicles, 4 must be flexible-fueled vehicles (FFVs) of differing models capable of operation on ethanol-gasoline blends up to and including 85% ethanol (E85). All test vehicles shall be two-wheel drive and feature an automatic transmission. Each vehicle shall have a maximum of 20,000 miles on the odometer (exceptions must be approved by the EPA WAM) at the outset of the emissions test program. The vehicles shall be in good operating condition with no engine, transmission, or emission

system malfunctions indicated or observed. Only vehicles whose owner's manuals recommend the use of regular gasoline shall be recruited for this program.

Table 3-1 lists the target vehicles for recruitment. In cases where multiple vehicle models are listed for a given model year engine family, any model within that family may be selected. If model year 2007 vehicles are not available, 2008 model year vehicles may be substituted provided that these vehicles are of the same certification levels as indicated for the 2007 model year vehicles listed below or cleaner. If model year 2008 vehicles are selected, the contractor shall submit engine family data to the EPA WAM for confirmation and approval prior to recruiting any vehicles.

Table 3-1. Test Vehicles for Recruitment

Make	Year	Brand	Model	Engine	Family	T2 Bin	Note
GM	2007	Chevrolet	Cobalt/HHR	2.4L I4	7GMXV02.4029	5	
GM	2007	Chevrolet	Impala	3.5L V6	7GMXV03.5052	5	FFV
GM	2007	Buick/GMC/Saturn	Enclave/Acadia/Outlook	3.6L V6	7GMXT03.6151	5	
GM	2007	Chevrolet/GMC	Avalanche	5.3L V8	7GMXT05.3381	4	FFV
Toyota	2007	Toyota	Corolla	1.8L I4	7TYXV01.8BEA	5	
Toyota	2007	Toyota	Camry	2.4L I4	7TYXV02.4BEB	5	
Toyota	2007	Toyota	Sienna	3.3L V6	7TYXT03.3BEM	5	
Toyota	2007	Toyota	Tundra	4.0L V6	7TYXT04.0AEV	5	
Ford	2007	Ford	Focus	2.0L I4	7FMXV02.0VD4	4	
Ford	2007	Ford	500/new Taurus/Freestyle	3.0L V6	7FMXV03.0VED	5	
Ford	2007	Ford/Mercury	Explorer/Mountaineer	4.0L V6	7FMXT04.03DB	4	
Ford	2007	Ford	F150	5.4L V8	7FMXT05.44H2	8	FFV
Chrysler	2007	Dodge	Caliber	2.4L I4	7CRXB0144M80	5	
Chrysler	2007	Dodge/Chrysler	Caravan/Town & Country	3.3L V6	7CRXT03.3NHP	8	FFV
Chrysler	2007	Jeep	Liberty	3.7L V6	7CRXT03.7NE0	5	
Honda	2007	Honda	Civic	1.8L I4	7HNXV01.8MKR	5	
Honda	2007	Honda	Accord	2.4L I4	7HNXV02.4KKC	5	
Honda	2007	Honda	Odyssey	3.5L V6	7HNXT03.5VKR	5	either family
					7HNXT03.5WKR		cylinder deact.
Nissan	2007	Nissan	Altima	2.5L I4	7NSXV02.5G5A	5	

All candidate vehicles recruited by the contractor shall be inspected and prepared for testing according to the methodology outlined in Task 5.

Task 4 Test Fuels and Lubricants

As Per Amendment 3

Task 5 Vehicle Preparation

Vehicles shall undergo a thorough inspection before beginning the test preparation sequence. This includes inspection of the engine, transmission, axles, exhaust system and tires, and verification that no OBD2 faults are set. Photographs of exhaust system layout shall be taken. The contractor shall collect and record vehicle information described in Appendix C for entry into MSOD data tables.

Following the inspection, a single FTP test shall then be performed using a baseline fuel (TBD) with bag measurements of THC, NMHC, NO_x, CO, and PM emissions. The results of this initial test shall be submitted to the EPA WAM for review to determine the vehicle's acceptability as a candidate vehicle for the test program. If accepted by EPA, an approved candidate vehicle may begin mileage accumulation and/or preparations for testing as outlined below.

Each vehicle approved by the EPA WAM shall then undergo initial crankcase oil, oil filter and air filter replacement. Air filters shall only be replaced in used vehicles (vehicles with more than 4,000 odometer miles). Oil and air filters shall be procured by the contractor per manufacturer's recommendations. One of the EPA-supplied lubricants shall be used per the vehicle manufacturer's viscosity requirements.

If the procured vehicle is used (has more than 4000 miles on the odometer), the engine oil and oil filter shall be replaced a second time following a full engine warm-up. The lubricant level in the sump shall be allowed to stabilize and its level indicated on the dipstick shall be recorded. The vehicle shall then be driven 500 miles on non-oxygenated, commercial, 87 octane gasoline to condition the lubricant in preparation for the emissions test program. Mileage accumulation shall either be done on a chassis dynamometer using the Standard Road Cycle or the vehicle shall be driven primarily on local interstates at or below posted speed limits.

If the procured vehicle is new (less than 4,000 miles), it shall be driven to 4,000 odometer miles either by operating it on a mileage accumulation dynamometer using the Standard Road Cycle or the vehicle shall be driven primarily on local interstates at or below posted speed limits. The fuel shall be a non-oxygenated, commercial, 87 octane gasoline. At the 2,000 mile odometer reading, crankcase oil and oil filter shall be replaced a second time. The vehicle shall then be driven to make sure that fresh oil and the remainder of used oil have mixed well in the sump and a 4 oz. sample of oil shall be taken from the engine. The lubricant level in the sump shall be allowed to stabilize and its level indicated on the dipstick shall be recorded. Mileage accumulation will then resume and continue until odometer reading of 4,000 miles is attained. The oil sample shall be shipped immediately to the following address:

Lubrizol Corporation
1275 Lloyd Road (Bldg 8)
Wicliffe, OH 44092

Attn: Dr. Ewa Bardasz

After the last test of each vehicle in the program, the contractor shall record the lubricant level indicated on the dipstick before collecting a 1 quart oil sample for analysis as described in Task 4, above.

Following mileage accumulation and lubricant conditioning, each new vehicle shall once again undergo thorough inspection of the engine, transmission, axles, exhaust system and tires, and verification that no OBD2 faults are set. At that time, the second 4 oz. engine oil sample shall be taken and shipped to Lubrizol. Used vehicles need not undergo this inspection a second time.

Additional 4 oz. engine oil samples shall be taken and shipped to Lubrizol following emissions testing of the 4^{th}, 14^{th} and 25^{th} fuel in the Phase 3 test sequence of each vehicle.

If any test vehicle is equipped with traction control, the contractor shall ensure that the latter is disabled either through an interior disable button or other method (remove power fuse to anti-lock brake system (ABS)), and place a placard in the vehicle indicating the method of disabling traction control if driver input is required. The vehicle shall use a 75°F road load horsepower setting derived from the coastdown coefficients as proposed by the contractor and approved by the EPA WAM. For the purpose of this study, the agreed road load setting shall remain the same for all testing on a given vehicle including the cold temperature testing.

Task 6 Vehicle Testing

6.1 Basic Testing Protocol

The basic testing protocol is the testing of the recruited vehicles across all the test fuels over the California Unified Cycle (LA92) as a three phase, cold start test at FTP ambient and load conditions. Limited testing shall also be done at 50°F. All tests on a given vehicle must be done using the same 48-inch single roll (or equivalent) electric chassis dynamometer. More than one such dynamometer may be used in this program. The same driver shall also be used for all tests on a given vehicle (for all test repeats and across all test fuels). The contractor may comment on the feasibility of these requirements and propose additional measures that will reduce test to test variability, such as multi-shift testing on fewer chassis dynamometers.

Prior to any emission test conducted in this program, the representative bulk oil temperature in the sump shall be stabilized within ±3°F of the nominal test temperature, 50±3°F or 75±3°F. The representative oil temperature is defined in 40 CFR Part 86.232-94.

During tests performed at FTP ambient conditions, intake air temperature and humidity shall be maintained at 75±2°F and 75±5 grains H_2O/lb dry air, respectively. During tests performed at 50°F, intake air temperature shall be maintained at 50±2°F. The contractor shall recommend the intake air humidity setting and tolerance for 50°F emission tests which must be approved by the WAM before 50°F testing can begin.

The emission test program shall be executed in the following sequence:

Phase 1: Fuels 17, 18 and 19 tested in all vehicles at 75°F

Phase 2: Fuels 17, 18 and 19 tested in all vehicles at 50°F

Phase 3: Fuels 1-16 tested in all vehicles at 75°F

In Phases 1 and 2 of the program, the test fuels shall be tested in each vehicle in the following sequence: Fuel 17 (E0) followed by fuel 18 (E10) and then fuel 19 (E15).

In Phase 3 of the program, the order in which the various test fuel and vehicle combinations are to be tested shall be randomized. However, replicate tests of a given fuel in a particular vehicle shall be done back-to-back. Specifically, the vehicle shall be tested twice (3 times if determined necessary per emissions variability criteria provided in Table 6.1-3 below) on a given fuel before moving on to the next test fuel in the matrix. This "back-to-back" testing eliminates the need to repeat additional vehicle preps (steps 1-6 of Table 6.1-1, below) between each replicate test on a given fuel.

The EPA requests that Phase 1 test results be made available as early as possible in the second quarter of 2008. The contractor shall comment on the feasibility of launching and completing Phase 1 of this program in the most expeditious manner.

While it is preferable that Phase 2 of this program be completed immediately following Phase 1, it may also be carried out, as a block, shortly following the launch of Phase 3.

The sequence of events for the testing of an individual vehicle is summarized in Tables 3a and 3b. All vehicles shall be tested two or three times on each fuel at each test temperature (replicate tests). The need for a third test will be determined based on the variability of the previous two replicates (see step 14 in Table 6.1-1, below).

The emissions to be measured and reported are THC, NMHC (by FID), NMOG, NO_x, NO_2, CO, CO_2, ethanol, PM, speciated VOCs, N_2O, NH_3 and HCN. The contractor shall comment on the feasibility and cost of incorporating bag (phase) level measurement of ethanol emissions by means of INNOVA photoacoustic analyzer.

More specifically, the following exhaust emission measurements shall be made:

1. Bag (phase) level and composite THC, NMHC, NMOG, CO, CO_2, NO_x, NO_2, ethanol and PM emissions

2. Bag (phase) level speciated VOCs for a subset of tests (See Task 6.2, below). The list of compounds to be measured and analyzed is given in Appendix D

3. Continuous and integrated by bag (phase) emissions of the following species in raw exhaust: THC, NMHC, CO, CO_2 and NO_x

4. Continuous and integrated by bag (phase) emissions of the following species measured in raw exhaust for a subset of tests (see Task 6.3.2, below): N_2O, NH_3 and HCN

Light-duty FTP weighting factors shall be used to calculate composite emissions. In addition, the contractor shall report bag (phase) level and total test cycle work measured at the wheels.

The contractor shall acquire all available data from the vehicle's onboard diagnostic (OBD) system during all emissions tests using contractor-supplied data acquisition equipment. The contractor shall comment on the feasibility of this requirement and the capability of the available data acquisition equipment to meet this requirement.

The facilities for testing shall meet the requirements of 40 CFR Part 86 Subpart B and 40 CFR Part 86 Subpart C as they apply to vehicle exhaust testing. THC, NMHC, NMOG, NO_x, NO_2, CO, and CO_2, and PM emissions sampling and measurement shall be conducted as specified in 40 CFR 1065. The minimum detection limit for NO_2, measurements shall be 5 ppb. If some aspect of testing will need to be done in variance to the above specifications the contractor shall describe why that is the case and how it may impact the test results. Variances must be approved the EPA WAM before testing may begin. The methodology to be used for determining NMHC and NMOG emissions is described in the CARB document "California Non-Methane Organic Gas Test Procedures[i]"

The contractor shall recommend sample collection and analytical methods for non-standard emission measurements. These recommendations will take into account analytical detection limits, emission rates expected of Tier 2 vehicles and the requirement to collect all samples in the course of a single LA92 test. All sample collection and analytical methods related to non-standard emission measurements must be approved by the EPA WAM.

6.1.1 Fuel Change and Test Execution Sequence

The contractor shall follow the fuel change and test execution sequence as described in Table 6.1-1, below.

In the course of each phase of EPAct Program, the first two emission tests on a given vehicle and fuel combination shall be performed back-to-back. After two tests have been completed and the acquired data has passed all quality control verifications as described in the contractor's QAPP, the need for a third test shall be determined by following the variability criteria shown in Table 6.1-3. Specifically, if the ratio of CO_2, NO_x or NMHC results in a pair of tests on a given vehicle and fuel combination exceeds the levels shown in Table 6.1-3, the contractor shall proceed with the third test and promptly notify the EPA WAM, making available the electronic summary reports of the tests in question. The third replicate shall be run the same way as the

second. The second and the third replicates shall also be done back-to-back.

Table 6.1-1. Fuel Change and Test Execution Sequence

Step	Description
1	Drain vehicle fuel completely via fuel rail whenever possible
2	Turn vehicle ignition to RUN position for 30 seconds to allow controls to allow fuel level reading to stabilize. Confirm the return of fuel gauge reading to zero
3	Fill fuel tank to 40% with next test fuel in sequence. Fill-up fuel must be at the temperature of the next LA92 test (75 or 50°F)
4	Start vehicle and execute catalyst sulfur removal procedure described in Appendix C of CRC E-60 Program report. Engine oil temperature in the sump shall be measured and recorded during the sulfur removal cycle.
5	Drain fuel and refill to 40% with test fuel. Fill-up fuel must be at the temperature of the next LA92 test (75 or 50°F)
6	Start vehicle and drive one LA4 cycle. Allow vehicle to idle in park for 2 minutes before engine shut-down
7	Move vehicle to soak area without starting or driving
8	Park vehicle in soak area at proper temperature (75 or 50°F) for 12-36 hours
9	Move vehicle to test area without starting engine
10	Perform LA92 cycle emissions test
11	Park vehicle in soak area of proper temperature for 12-36 hours
12	Move vehicle to test area without driving
13	Perform LA92 emissions test
14	Determine whether third replicate is necessary, based on data variability criteria (see Table 6.1-3 below)
15	If a third replicate is required, repeat steps 11, 12 and 13
16	If third replicate is not required, return to step 1 and proceed with next fuel in test sequence

Table 6.1-3. Variability Criteria for Triplicate Testing

Dilute Gaseous Emission	Criteria for requiring a third test (composite cycle emissions)
CO_2	Ratio of higher / lower > 1.04
NOx	Ratio of higher / lower > 1.81
NMHC	Ratio of higher / lower > 1.67

6.2 Speciation of Volatile Organic Compounds (VOCs)

VOC speciation shall include C1-C12 hydrocarbons as well as light alcohols, and carbonyls. Sampling and analysis of C2-C12 hydrocarbons will be done using CARB method 1002/1003, "Procedure for the Determination of C2-C12 Hydrocarbons in Automotive Exhaust Samples by Gas Chromatography". Sampling and analysis of carbonyl compounds will be done using CARB method 1004, "Determination of Aldehyde and Ketone compounds in Automotive Source Samples by High Performance Liquid Chromatography". Analysis of C1 – C4 HC samples shall be done within one hour of completion of the emissions test. Subsequent analysis of the additional compounds of interest shall be done within 4 hours of emission test completion. The time between sample collection and the start of C1-C4 HC analysis shall be reported. The VOCs to be analyzed are identified in Appendix D. The contractor shall comment on the feasibility of these requirements and propose additional measures to improve the precision of VOC speciation. All methods used in the measurement of VOCs must be approved by EPA WAM.

In Phases 1, 2 and 3 of the program, VOC speciation shall be performed for all 3 test phases of the LA92 cycle, on all fuels (3 fuels in Phases 1 and 2, and 16 fuels in Phase 3), for a subset of 3 vehicles (vehicles to be selected by the EPA WAM). This includes all repeat tests, and is outlined graphically in Table 6.2-1, below.

Table 6.2-1: VOC Speciation Summary for 3 Vehicles in Program Phases 1, 2 and 3

	LA92 Test Repeat		
LA92 Test Phase (bag)	**1**	**2**	**3**
1	C1-C12 Speciation Alcohols Carbonyls	C1-C12 Speciation Alcohols Carbonyls	C1-C12 Speciation Alcohols Carbonyls
2	C1-C12 Speciation Alcohols Carbonyls	C1-C12 Speciation Alcohols Carbonyls	C1-C12 Speciation Alcohols Carbonyls
3	C1-C12 Speciation Alcohols Carbonyls	C1-C12 Speciation Alcohols Carbonyls	C1-C12 Speciation Alcohols Carbonyls

The remaining 16 vehicles shall only require VOC speciation in phase 1 of the LA92 test, also for all test fuels (3 fuels in Phases 1 and 2, and 16 fuels in Phase 3). This also includes all repeat tests and is outlined in Table 6.2-2, below.

Table 6.2-2: VOC Speciation Summary for 16 Vehicles in Program Phases 1, 2 and 3

	LA92 Test Repeat		
LA92 Test Phase (bag)	**1**	**2**	**3**
1	C1-C12 Speciation Alcohols Carbonyls	C1-C12 Speciation Alcohols Carbonyls	C1-C12 Speciation Alcohols Carbonyls
2	none	none	none
3	none	none	none

The CARB procedure for calculating NMHC and NMOG (mentioned above and referenced at the end of this document) shall be followed. Phase-level NMOG shall be calculated for all phases where the required measurements are available (i.e. NMHC, carbonyls, and light alcohol measurements are made). In cases where one or more components of the phase-level NMOG calculation is not measured (for example, when carbonyls are not measurement in phases 2 and 3 of some tests) the contractor shall calculate phase-level NMOG mass emissions assuming the missing measurements are below method detection limits. These phase-level NMOG calculations shall then be used to calculate composite weighted NMOG mass emissions. In all cases, the contractor shall report all measured phase-level NMOG components (i.e. each compound quantified) separately along with the associated FID response factors used in NMOG and NMHC determination.

6.3 Continuous Measurements of Gaseous Emissions in Raw Exhaust

6.3.1 Continuous THC, NMHC, CO, CO_2 and NO_x

As Per Amendment 3

6.3.2 Continuous N_2O, NH_3 and HCN

Continuous and integrated by bag (phase) emissions of N_2O, NH_3 and HCN shall be measured using Fourier Transform Infrared Spectroscopy (FTIR) or an alternate method proposed by the contractor and approved by the EPA WAM.

The measurements of N_2O, NH_3 and HCN emissions shall only be done in Phase 1 of the program, during the first test of each fuel/vehicle combination. No repeat measurements are required.

The contractor shall provide a separate cost estimate for the measurement of continuous and integrated by bag (phase) emissions of N_2O, NH_3 and HCN by FTIR in Phase 2 of the program and separately during E85 tests in four FFVs in Phase 3 of the program

Task 7 Deliverables

7.1 Weekly Reports

As Per Amendment 3

7.2 Monthly Written Progress Reports
As Per Amendment 3

7.3 Data Files

As Per Amendment 3

7.4 Mode of Delivery

As Per Amendment 3

7.5 Draft Final Report

As Per Amendment 3

7.6 Final Report

As Per Amendment 3

Schedule of Deliverables

As Per Amendment 3

Work Assignment Manager (WAM)	Constance Hart, 734/ 214-4340
Alternate WAM	Rafal Sobotowski, ASD 734/214-4228
Technical Contacts	Michael Christianson, ASD 734/214-4624 Antonio Fernandez, ASD 734/214-4431 Carl Fulper, ASD 734/214-4400

The above Technical Contracts are able to communicate with the contractor. However it will be technical communication vice technical direction. Per the technical direction clause EPAAR 1552.237-71 of the contract, the PO and the WAM or alternate WAM are the primary representatives of the CO authorized to provide technical direction.

[i] "California Non-Methane Organic Gas Test Procedures". Amended version, July 30, 2002. Available online at the California Air Resources Board website: http://www.arb.ca.gov/msprog/levprog/cleandoc/clean_nmogtps_final.pdf.